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AUTHOR Moersch, Christopher M.
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ABSTRACT

Since the publication of "A Nation at Risk," curriculum leaders have been under increased pressure to make more prudent, informed decisions about allocating district resources that will directly or indirectly lead to increased student achievement. The decision-making process should include a thorough investigation of the best and most cost-effective methodologies, strategies, and programs to achieve the desired outcomes. This paper summarizes the results of a study to provide Grossmont Union High School District (San Diego County, California) with a basis for comparing the effects of computer-assisted learning, cooperative learning, peer tutoring, and class size on academic achievement. A literature review yielded encouraging evidence concerning the effectiveness of cooperative learning and peer tutoring for increased academic achievement. Cooperative learning, employing the group study approach and group rewards for individual learning, produced higher achievement gains than conventional instruction. Numerous research studies support computer-based instruction as a viable supplementary medium for increasing student achievement, although additional research into microcomputer applications is needed. Class size had the least empirical support as a viable strategy for increasing student achievement. Excluded from this study were per capita student costs, physical space requirements, and scheduling considerations--important factors when allocating district funds to support a particular program. Included is a bibliography of 42 references. (MLH)

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The Effectiveness of Computer-Assisted Instruction, Cooperative Learning, Peer Tutoring, and Class Size on Academic Achievement: A Review

Christopher M. Moersch

Western Oregon State University

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Paper presented at the Instructional Leadership Institute, July, 1987, San Diego State University, San Diego, California. Address correspondence to Christopher M. Moersch, 3106 N.W. Harrison, Corvallis, Oregon 97330.

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Christopher Moersch, Ed.D.

The Effectiveness of Computer-Assisted Instruction, Cooperative Learning, Peer Tutoring, and Class Size on Academic Achievement: A Review

The decade of the 1980s has once again witnessed education's emergence into the national spotlight. Commencing with the A Nation At Risk: The Imperative for Educational Reform report in 1983, over 20 national commissions have reported on the deplorable status of America's secondary schools (Kirst, 1984). A steady decline in Scholastic Aptitude Test scores, the lack of substantive rigor in academic offerings, and a fragmented and unregulated curriculum are reoccurring themes in many of these published reports (Action For Excellence, 1983; A Nation At Risk, 1983; Education and Economic Progress, 1983; and Investing In Our Children, 1985). Echoing the tenor of the business community, the December 29, 1986 issue of Forbes lambasted education's lack of accountability based on a deterioration of Scholastic Aptitude Test scores for high school students that coincided with a substantial increase in per pupil expenditures during the past 20 years. Locally, as standardized, norm-referenced testing gains added momentum and notoriety as the "unofficial" barometer of a school district's success, curriculum leaders are under increased pressure to make more prudent and informed decisions about the allocation of district resources that will directly or indirectly lead to increased student achievement.

Part of the decision-making process should include a thorough investigation of the most optimum and cost-efficient methodologies, strategies, and programs that can best achieve the desired outcomes. In many instances, a decision to implement a capital or labor intensive program (e.g., computer-based instruction) may not have met a district's preconceived expectations because either the district's goals and objectives were not used as a framework for making choices between competing strategies or insufficient research was conducted to weigh the relative merits of each strategy against the desired outcomes.

This study was initiated to provide the Grossmont Union High School District in San Diego County a basis for comparing the effects of computer-assisted instruction, cooperative learning, peer tutoring, and class size on student academic achievement. The study represented one component of a district-funded project to determine the fiscal, logistical, and pedagogical feasibility of implementing computer-assisted instruction (CAI) in its ten comprehensive high schools and continuation education programs. Provided below is a summary of the research findings pertaining to four strategies for improving student achievement.

Computer-Assisted Instruction

Computer-assisted instruction (CAI) or computer-based instruction (CBI) "describes an activity whereby the computer is used as the 'means' of problem solving, drill and practice,

simulation, or tutorial experience" (Muscat & Lorton, 1983). Evaluation studies involving the effectiveness of CAI on student achievement have yielded significant results substantiating CAI utilization (Jamison, Suppes, and Wells, 1974; Dence, 1980; Billings, 1983; Bangert, Kulik, and Kulik, 1985; and Okey, 1985).

In a meta-analysis conducted by Kulik, Bangert, and Williams (1983), integrating the findings of 51 independent evaluations on computer-based teaching at the secondary level, the analysis identified an increase of approximately .32 standard deviations in student final examination scores. The independent studies selected by Kulik, Bangert , and Williams were limited to those evaluations encompassing grades 6-12, measuring outcomes in both CBI and control classes, and employing an analytical package relatively free of "crippling methodology flaws" (p. 21).

The meta-analysis by Kulik, Bangert, and Williams corroborated the findings of Vinsonhaler & Bass (1972) relating increased student achievement in mathematics to CAI interventions. Burns & Bozeman (1981) used a similar meta-analysis approach to integrate 40 separate studies of CBE in mathematics and concluded that, "the analysis and synthesis of many studies do point to a significant enhancement of learning in instructional environments supplemented by CAI."

Though the vast majority of research studies with computer-based education (CBE) in the late 1960s and 1970s focused primarily on mainframe computer use, Wise and Okey (1983) were able to locate 12 CBE studies utilizing the microcomputer. Their findings showed an average effect size of .82 which corresponded to a shift in achievement of 29 percentile units for those students receiving CBE interventions from microcomputers.

As concluded by Fletcher and Suppes (1972), and Jamison et al. (1973), a review of the literature reveals "practically no negative findings in CAI evaluations." Okey (1985) summarized the effects of CAI interventions on the learning process as follows:

> 1. CBE is effective in promoting learning. The effects are consistent across dozens of studies. Rarely is conventional instruction superior.
>
> 2. Positive effects of CBE have been found in a variety of curriculum areas although studies in math and science predominate. Young children seem to be affected more powerfully than older learners and low ability more strongly than high ability.
>
> 3. Computer-assisted instruction shows a larger impact on achievement than computer-managed instruction. The effectiveness of drill and practice CBE is prominent in the literature but more studies have been done in this area than in

> any other. Supplemental instruction with computers may be more effective than providing a total computer environment.
>
> 4. The trends in CBE are to extend computer use to a wider range of outcomes -- simulations and problem solving are now studied as well as drill /practice and tutorial modes (p. 6).

In reviewing five major research studies pertaining to CAI effectiveness (Vinsonhaler and Bass, 1972; Edwards et al., 1975; Burns and Bozeman, 1981; Kulik, J. et al., 1983; and Kulik, C.C. et al., 1984), Stennett (1985) reported that "well-designed and implemented D & P (drill and practice) or tutorial CAI, used as a supplement to traditional instruction, produces an educationally significant improvement in students' final examination achievement" (p. 9).

A review of the research involving CBE interventions appears to suggest some promise for improving student academic achievement. Twenty years of well-documented studies have shown increases in student academic achievement in subjects ranging from reading to science. However, there are still some concerns with computer-assisted instruction which are still unresolved. Stennett (1985) suggests that "there is no substantial research on micro-based CAI..., and more importantly, there are no clear answers at present as to which particular features of CAI are responsible for its beneficial effects" (p. 9).

Cooperative Learning

Kagan (1986) refers to cooperative learning as the "...structuring of classrooms so that students (can) work together in small cooperative teams" (p. 231). The effect of cooperative learning on academic achievement has been well-documented (Johnson et. al., 1981; Slavin, 1982; Slavin, 1984; Slavin and Oickle, 1981; Parker, 1985; and Ascher, 1986). The research suggests convincingly that cooperative learning techniques produce greater student academic achievement than conventional teaching methodologies.

Johnson et al. (1981) used a meta-analysis approach to review 122 studies on cooperative learning. Their analysis corroborated the findings of comparable research studies (e.g., Slavin and Oickle, 1981) by suggesting that cooperative learning strategies promote greater student academic gains than conventional classroom practices. Beyond academic achievement, Cooper and others (1980) found that students "who were initially prejudiced against one another evidenced greater interpersonal attraction in an experimental cooperative setting than did students in competitive and individualistic settings" (p. 3).

Parker (1985) cited the advantages of the cooperative learning design as benefiting both high and low achieving students:

> Students benefit from the help of their peers and from the opportunity to hear and experience more ways to solve problems. Small groups provide a safe place for low achievers to become involved in their learning. Encouraged to cooperate, they are no longer left to succeed or fail on their own.
>
> High-achieving students also show superior academic gains with small-group learning. Within traditional classrooms these students often rush through assignments with very little thinking required of them. In a cooperative group high achievers have the opportunity to clarify their own thought processes while explaining ideas to other group members (p. 50).

In reviewing the abundance of cooperative learning-based studies, Slavin (1984) attempted to isolate the salient characteristics or variables within the cooperative learning model which were primarily responsible for increased student productivity in the classroom. In his review, Slavin distinguished between "cooperative task structure" and "cooperative incentive structure" as the two principal variables responsible for student academic gains.

Cooperative task structures, which include task specialization (each group member responsible for a section of the group activity) and group study (all group members study together) are situations in which two or more students are prompted, encouraged, or otherwise required to perform together on some pre-determined task. A cooperative incentive structure, on the other hand, is a situation where two or more students work interdependently to receive a reward they will share if they are successful as a group.

Using 46 separate field experiments on cooperative learning, Slavin found that 63% of the studies showed significant positive effects on academic achievement. Curiously, the critical variable in those studies producing significant achievement results was not the type of task structure; rather, it was the type of incentive structure and most predominately, the use of the "group reward" for individual learning. According to Slavin, "... student achievement can, therefore, be enhanced by use of cooperative learning methods that use group study and group rewards for individual learning..." (p. 60).

Kagan (1986) revealed a substantial difference in the reward structure in a cooperative learning approach versus conventional instruction. Student rewards in the cooperative learning classroom occur at a greater frequency, are peer supported, and are primarily group-based. The use of the group reward as a causal variable for increased academic performance was well documented by both Slavin (1984) and Hamblin et. al. (1971) in their studies on cooperative learning.

The teacher/student dynamic also changed in the cooperative learning configuration. Kagan stressed that "...teachers may have a more equitable distribution of their expectations and

attention especially toward minority students" (p. 260). The cooperative learning experience provided students with a greater sense of efficacy toward academic outcomes and increased opportunities for verbal communication.

In a research study investigating the interaction effect of cooperative learning and ethnicity on achievement, Slavin and Oickle (1981) found that minority students gained more academically than non-minority students as a consequence of working cooperatively. These findings confirmed the earlier work of Lucker et al. (1976) and Slavin (1977). According to Slavin and Oickle, "...cooperative learning strategies apparently have the capability to significantly reduce achievement disparities between blacks and whites" (p. 179).

The research suggests that cooperative learning can lead to increased academic achievement as well as serve as a vital medium for student acquisition of the social goals of schooling, such as developing skill in communicating effectively in groups and developing skill in democratic action both in large and small groups.

Peer Tutoring

Tutoring refers to an arrangement whereby a child is taught either by other children or by paraprofessionals rather than by classroom teachers (Cohen, 1981). Similar to cooperative learning, the effect of peer tutoring programs on academic growth has a large cadre of supporters in the field. (Devin-Sheehan, 1976 and Fitz-Gibbon, 1977). Each of these reviewers found positive effects of tutoring on academic achievement for both the tutor and tutee. However, Cohen (1981) pointed out that although many of these research attempts arrived at the general conclusion that tutoring was a worthwhile endeavor, they, nevertheless, suffered from the same design flaws (e.g., use of subjective, narrative techniques to summarize evaluation findings) of earlier reviews.

In an attempt to address some of these design issues, Cohen (1981) conducted a meta-analysis of peer tutoring involving 65 separate research studies. His results describing the academic achievement effects on tutees and tutors are outlined below:

> Effects on Tutees
>
> Fifty-two of the 65 studies examined the effect of tutoring on tutee achievement. Overall, pupils who were tutored outperformed pupils who were not tutored in 87% of these studies. Of the studies reporting statistically significant differences between teaching approaches, 95% favored tutees.

Effects on Tutors

> Overall, the examination performance of tutors was better than the examination performance of pupils in a conventional class in 87% of the 38 studies. Ten of the comparisons reported statistically significant results, and in each case the difference favored tutors (pp. 2-3).

In addition, Cohen, Kulik, and Kulik (1981) found that "tutoring effects were larger in more structured programs, and in tutoring programs of shorter duration" (p.243). Cohen, Kulik, and Kulik also found effects to be larger when mathematics rather than reading was the subject of tutoring.

In his review of cooperative learning studies, Kagan (1986) revealed a surprising result when peer tutoring was used within a cooperative learning configuration. Kagan reported that "peer tutoring without group reward was not associated with achievement gains beyond those found in traditional classroom formats" (p. 264). Kagan reconciled this apparent contradiction of the positive results of peer tutoring by commenting, "Peer tutoring is probably almost always effective, but in team situations in which there is no group reward... there is little motivation for peer tutoring..." (p. 264).

Aside from the Kagan review, the meta-analysis and previous reviews of peer tutoring confirm the benefits of this instructional strategy for tutors and tutees on the cognitive and affective levels. In many respects, the attributes of peer tutoring and cooperative learning are similar. Both approaches allow for social interaction within a small group as well as provide a medium for students to explain or clarify their understanding of a specific concept, process, or skill to one or more peers.

Class Size

Few classroom teachers would discount the virtues of smaller class sizes. In fact, the 1980s are witnessing a nationwide trend toward reduced class sizes. Legislative mandates including the Texas Educational Improvement Act of 1985, the Florida Primary Education Program and the State of New York's Early Grade Intervention Aid have provided funding for the reduction in class sizes at the primary grades (Robinson and Wittlebols, 1986). Yet a review of the literature on the effect of class size on academic achievement would suggest a significant degree of controversy among scholars as to the merits of class size reductions.

Two of the more significant reports which keenly illustrate this lack of a group consensus within the research community involve studies by Glass and Smith (1978) and the Educational

Research Service. Excerpts from the Glass and Smith study appear below:

> 1. ...average pupil achievement increases as class size decreases.
>
> 2. The typical achievement of pupils in instructional groups of 15 and fewer is several percentile ranks above that of pupils in classes of 25 and 30.
>
> 3. ...achievement appears to increase dramatically only when class size drops below 20 (Cacha, p.14).

Glass and Smith's study, which suggests an inverted relationship between class size and student achievement, corroborated the findings of Walberg (1982), Hedges and Stock (1983), and Cotton and Savard (1980). However, Cotton and Savard qualified their findings by stating that "reducing or increasing class size will not automatically produce any particular, foreseeable effect on achievement;... however, smaller class size has the potential for stimulating the development and use of improved instructional methods, but will not automatically do so."

On the other hand, the Educational Research Service in 1978 reported "the relationship of class size and achievement to be not only inconclusive but also contradictory and very complex" (Cacha, p. 13). The Educational Research Service study further concluded that:

> The present class size studies do not indicate that there is an optimum class size for all grade levels in all subjects. Where there are efficient class sizes, they are products of one or more additional variables, for example, type of students, teacher personality and skills, availability of resources, methods, and materials used (Cacha, pp. 13-14).

In examing the differences in class sizes on several different dependent variables including academic achievement, Wright (1977) reported a statistically significant class effect in only one of four areas assessed, mathematics concepts. No significant differences were found for the measure of student achievement in reading, vocabulary, composition, art, and mathematics problem solving.

In a study involving 791 students in 26 classes with teacher-pupil ratios ranging from 25 to 1 to 34 to 1 respectively, Hallinan and Sorensen (1985) found that, "in classes where teachers employ whole-class instruction, class size has no significant effect on learning." Additionally, Hallinan and Sorensen concluded that in "classes where students are ability-grouped for instruction, group size rather than class size affects achievement..."(p.86).

In this context, class size has an indirect effect on academic achievement because "...class size affects the teacher's pedagogical practices, which, in turn, have a pronounced effect on student achievement" (p. 87).

In citing the research of Cotton and Savard, Albritton (1984) discussed the role of the teacher as the ultimate influence on academic achievement rather than class size. The types of decisions made by the classroom teacher in relation to grouping, teaching strategies, and time will dictate the success or failure of a class of any size. In reviewing studies conducted from 1950 to 1985, Robinson and Wittlebols (1986) provide perhaps the most indepth and comprehensive summary of research relating to class size. They offer the following generalizations:

> • Research to date provides no support for the concept of an "optimum" class size in isolation of other factors. Rather, the indications are that efficient class sizes are the product of many variables including: grade level, subject area, nature of pupils in the classroom, nature of learning objectives, availability of materials and facilities, attitudes of the teacher and support staff, and budgetary constraints.
>
> • Existing research findings do not support the contention that smaller classes will of themselves result in greater academic achievement gains for pupils. The evidence is that within the mid-range of about 23 to 30 pupils, class size seems to have little if any decisive impact on the academic achievement of most pupils in most subjects above the primary grades.
>
> • There is some evidence that pupils of lesser academic ability tend to achieve more in smaller classes. The evidence is mixed concerning students of average or higher academic abilities.
>
> • Research indicates that smaller classes can positively affect the academic achievement of economically disadvantaged and ethnic minority students.
>
> • Research indicates that few, if any, pupil benefit can be expected from reducing class size if teachers continue to use the same instructional methods and procedures in the smaller classes that they used in the larger classes.
>
> • Smaller classes appear to have a positive effect on pupil behavior and attitude in the early primary grades. At the junior and senior grade level, the majority of studies to date have found no significant differences in student behavior and attitudes between the smaller and larger classes (pp. 203-204).

Summary

A review of the literature yielded encouraging evidence as to the effectiveness of cooperative learning and peer tutoring for increased academic achievement. The cooperative learning strategy, which employed the group study approach and group rewards for individual learning, tended to produce higher achievement gains as compared to conventional instruction. The research supported peer tutoring as an effective device for improving academic achievement for both tutors and tutees.

The results of numerous experimental and meta-analytical studies encompassing computer-assisted instruction are also noteworthy. The plethora of research studies and reviews support CAI as a viable, supplemental medium for increasing student achievement. However, the reviewers qualified their findings by citing the need for additional research into CAI microcomputer applications and alternative research designs that attempt to "isolate" particular attributes of the technology.

Class size was found to have the least empirical support as a viable strategy for increasing student academic achievement. The research suggested that variables other than class size have potentially greater impact on student achievement. The findings from the reviews on class size tended to dispute the intuitive notion that class size reductions automatically result in increased academic achievement.

Excluded from this study was any mention of the per pupil costs, physical space requirements, and scheduling considerations associated with the implementation of any one of these strategies as well as a comprehensive review of the effect of each strategy on the personal and social goals of schooling. Each should be an important consideration when allocating district funds to support a particular program. A strategy that is able to achieve multiple goals of schooling like increasing student academic achievement (Intellectual Development), identifying with and advancing the goals and concerns of others (Social Development), and/or developing a positive attitude toward learning (Personal Development), along with meeting district fiscal and logistical requirements may,therefore, prove to be the most desirable, cost-efficient alternative available to the curriculum decision-maker.

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